Complete Summary

GUIDELINE TITLE

ACC/AHA 2006 guidelines for the management of patients with valvular heart disease. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease).

BIBLIOGRAPHIC SOURCE(S)

American College of Cardiology (ACC), American Heart Association (AHA), Task Force on Practice Guidelines, (Committee on Management of Patients with Valvular Heart Disease). ACC/AHA guidelines for the management of patients with valvular heart disease. J Am Coll Cardiol 1998 Nov;32(5):1486-588. [737 references] PubMed

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: American College of Cardiology (ACC), American Heart Association (AHA), Task Force on Practice Guidelines, (Committee on Management of Patients with Valvular Heart Disease). ACC/AHA guidelines for the management of patients with valvular heart disease. J Am Coll Cardiol 1998 Nov;32(5):1486-588.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Valvular heart disease:

- Cardiac murmurs
- Endocarditis and rheumatic fever
- Aortic stenosis
- Aortic regurgitation
- Bicuspid aortic valves with aortic root enlargement
- Mitral stenosis
- Mitral valve prolapse
- Mitral regurgitation
- Multiple valve disease
- Tricuspid valve disease
- Prosthetic heart valves, complications
- Coronary artery disease

GUIDELINE CATEGORY

Evaluation
Management
Treatment

CLINICAL SPECIALTY

Cardiology

INTENDED USERS

Physicians

GUIDELINE OBJECTIVE(S)

- To assist physicians in clinical decision making by describing a range of generally acceptable approaches for management of valvular heart disease
- To improve the effectiveness of care, optimize patient outcomes, and favorably affect the overall cost of care by focusing resources on the most effective strategies

TARGET POPULATION

Adults and adolescents with valvular heart disease

INTERVENTIONS AND PRACTICES CONSIDERED

General Interventions for Evaluation of Valvular Heart Diseases

1. Echocardiography (imaging, spectral, and color Doppler): transesophageal, transthoracic
2. Cardiac catheterization
3. Exercise testing
4. Radionuclide angiography
5. Antibiotic prophylaxis
6. Intraoperative transesophageal echocardiography

Interventions for Specific Valvular Diseases

Aortic Stenosis

1. Aortic valve replacement
2. Aortic balloon valvotomy

Aortic Regurgitation

1. Aortic root angiography
2. Vasodilator therapy
3. Aortic valve replacement
4. Repair of thoracic aorta in patients with bicuspid aortic valves

Mitral Stenosis

1. Anticoagulation
2. Percutaneous mitral balloon valvotomy
3. Mitral valve repair
4. Mitral valve replacement

Mitral Valve Prolapse

1. Aspirin
2. Oral anticoagulants

Mitral Regurgitation

1. Left ventriculography and hemodynamic measurements
2. Mitral valve repair
3. Mitral valve replacement

Tricuspid Regurgitation

1. Tricuspid valve repair, replacement, or annuloplasty

Pulmonic Stenosis

1. Intervention in the adolescent or young adult with pulmonic stenosis (balloon valvotomy or surgery)

Other Indications

1. Endocarditis and rheumatic fever prophylaxis
2. Evaluation of valvular heart disease associated with anorectic drugs
3. Surgery for native valve endocarditis
4. Antibiotics for native valve endocarditis
5. Surgery for prosthetic valve endocarditis
6. Antibiotics for prosthetic valve endocarditis

7. Anticoagulation during pregnancy in patients with mechanical prosthetic valves
8. Percutaneous or surgical mitral valve commissurotomy in rheumatic heart disease
9. Antithrombotic therapy for prosthetic heart valves
10. Valve replacement with a mechanical prosthesis
11. Valve replacement with a bioprosthesis
12. Aortic valve replacement in patients undergoing coronary artery bypass surgery

MAJOR OUTCOMES CONSIDERED

- Symptoms
- Functional status
- Contractile function
- Survival

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Hand-searches of Published Literature (Primary Sources)
Hand-searches of Published Literature (Secondary Sources)
Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The current writing committee was charged with revising the guidelines published in 1998. The committee reviewed pertinent publications, including abstracts, through a computerized search of the English literature since 1998 and performed a manual search of final articles. Special attention was devoted to identification of randomized trials published since the original document. A complete listing of all publications covering the treatment of valvular heart disease is beyond the scope of this document; the document includes those reports that the committee believes represent the most comprehensive or convincing data that are necessary to support its conclusions.

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

- Level of Evidence A: Data derived from multiple randomized clinical trials.

- Level of Evidence B: Data derived from a single randomized trial or nonrandomized studies.
- Level of Evidence C: Only consensus opinion of experts, case studies, or standard-of-care.

METHODS USED TO ANALYZE THE EVIDENCE

Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Evidence tables were updated to reflect major advances reported in the literature since the original 1998 guideline.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Experts in the subject under consideration are selected from the American College of Cardiology and the American Heart Association to examine subject-specific data and write guidelines. The process includes additional representatives from other medical specialty groups where appropriate. Writing committees are specifically charged to perform a formal literature review, weigh the strength of evidence for or against a particular treatment or procedure, and include estimates of expected health outcomes where data exist. Patient-specific modifiers, comorbidities, and issues of patient preference that might influence the choice of particular tests or therapies are considered as well as frequency of follow-up and cost-effectiveness.

The Committee on Management of Patients With Valvular Heart Disease was given the task of reviewing and compiling this information base and making recommendations for diagnostic testing, treatment, and physical activity.

Writing committee membership for the updated guideline consisted of cardiovascular disease specialists and representatives of the cardiac surgery and cardiac anesthesiology fields; both the academic and private practice sectors were represented. The Society of Cardiovascular Anesthesiologists assigned an official representative to the writing committee.

Inaccuracies or inconsistencies present in the original publication were identified and corrected when possible. Recommendations provided in this document are based primarily on published data. Because randomized trials are unavailable in many facets of valvular heart disease treatment, observational studies and, in some areas, expert opinions form the basis for recommendations that are offered. All of the recommendations in this guideline revision were converted from the tabular format used in the 1998 guideline to a listing of recommendations that has been written in full sentences to express a complete thought, such that a recommendation, even if separated and presented apart from the rest of the document, would still convey the full intent of the recommendation.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Class I: Conditions for which there is evidence and/or general agreement that this procedure is beneficial, useful, and effective.

Class II: Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.

Class IIa: Weight of evidence/opinion is in favor of usefulness/ efficacy.

Class IIb: Usefulness/efficacy is less well established by evidence/opinion.

Class III: Conditions for which there is evidence and/or general agreement that the procedure/treatment is not useful/effective and in some cases may be harmful.

COST ANALYSIS

Published cost analyses were reviewed.

METHOD OF GUIDELINE VALIDATION

External Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

The updated document was reviewed by 2 official reviewers nominated by the American College of Cardiology (ACC); 2 official reviewers nominated by the American Heart Association (AHA); 1 official reviewer from the ACC/AHA Task Force on Practice Guidelines; reviewers nominated by the Society of Cardiovascular Anesthesiologists, the Society for Cardiovascular Angiography and Interventions, and the Society of Thoracic Surgeons (STS); and individual content reviewers, including members of the American College of Cardiology Foundation (ACCF) Cardiac Catheterization and Intervention Committee, ACCF Cardiovascular Imaging Committee, ACCF Cardiovascular Surgery Committee, AHA Endocarditis Committee, AHA Cardiac Clinical Imaging Committee, AHA Cardiovascular Intervention and Imaging Committee, and AHA Cerebrovascular Imaging and Intervention Committee.

The "ACC/AHA 2006 Guideline for the Management of Patients With Valvular Heart Disease" was approved for publication by the ACCF board of trustees in May 2006 and the AHA Science Advisory and Coordinating Committee in May 2006. The executive summary and recommendations are published in the August 1, 2006 issue of the Journal of the American College of Cardiology and the August 1, 2006 issue of Circulation. The full-text guideline is e-published in the same issues of each journal and is posted on the World Wide Web sites of the ACC (www.acc.org) and the AHA (www.americanheart.org).

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

Definitions for the weight of the evidence (A-C) and classes of recommendations (I-III) are provided at the end of the "Major Recommendations" field.

Classification of the Severity of Valve Disease in Adults

A. Left-sided valve disease			
	Aortic Stenosis		
Indicator	Mild	Moderate	Severe
Jet velocity (m/s)	Less than 3.0	3.0-4.0	Greater than 4.0
Mean gradient (mm Hg)*	Less than 25	25-40	Greater than 40
Valve area (cm^2)	Greater than 1.5	1.0-1.5	Less than 1.0
Valve area index (cm^2/m^2)			Less than 0.6
	Mitral Stenosis		
	Mild	Moderate	Severe
Mean gradient (mm Hg)*	Less than 5	5-10	Greater than 10
Pulmonary artery systolic pressure (mm Hg)	Less than 30	30-50	Greater than 50
Valve area (cm^2)	Greater than 1.5	1.0-1.5	Less than 1.0
	Aortic Regurgitation		
	Mild	Moderate	Severe
Qualitative			
Angiographic grade	1+	2+	3-4+
Color Doppler jet	Central jet, width less than 25% of LVOT	Greater than mild but no signs of severe AR	Central jet, width greater than 65% LVOT
Doppler vena contracta width (cm)	Less than 0.3	0.3-0.6	Greater than 0.6
Quantitative (cath or echo)			
Regurgitant volume (ml/beat)	Less than 30	30-59	Greater than or equal to 60
Regurgitant fraction (%)	Less than 30	30-49	Greater than or equal to 50
Regurgitant orifice area (cm^2)	Less than 0.10	0.10-0.29	Greater than or equal to 0.30
Additional Essential Criteria			
Left ventricular size			Increased

A. Left-sided valve disease			
	Aortic Stenosis		
Indicator	Mild	Moderate	Severe
	Mitral Regurgitation		
	Mild	Moderate	Severe
Qualitative			
Angiographic grade	1+	2+	3-4+
Color Doppler jet width	Small, central jet (less than 4 cm^2 or less than 20% LA area)	Signs of MR greater than mild present but no criteria for severe MR	Vena contracta width greater than 0.7 cm with large central MR jet (area greater than 40% of LA area) or with a wall-impinging jet of any size, swirling in LA
Doppler vena contracta width (cm)	Less than 0.3	0.3-0.69	Greater than or equal to 0.70
Quantitative (cath or echo)			
Regurgitant volume (ml/beat)	Less than 30	30-59	Greater than or equal to 60
Regurgitant fraction (%)	Less than 30	30-49	Greater than or equal to 50
Regurgitant orifice area (cm^2)	Less than 0.20	0.20-0.39	Greater than or equal to 0.40
Additional Essential Criteria			
Left atrial size			Enlarged
Left ventricular size			Enlarged
B. Right-Sided Valve Disease	Characteristic		
Severe tricuspid stenosis:	Valve area less than 1.0 cm^2		
Severe tricuspid regurgitation:	Vena contracta width greater than 0.7 cm and systolic flow reversal in hepatic veins		
Severe pulmonic stenosis:	Jet velocity greater than 4 m/s or maximum gradient greater than 60 mm Hg		
Severe pulmonic regurgitation:	Color jet fills outflow tract; dense continuous wave Doppler signal with a steep deceleration slope		

*Valve gradients are flow dependent and when used as estimates of severity of valve stenosis should be assessed with knowledge of cardiac output or forward flow across the valve. Modified from Zoghbi WA, Enriquez-Sarano M, Foster E, et al. Recommendations for evaluation of the severity of native valvular regurgitation with two-dimensional and Doppler echocardiography. J Am Soc Echocardiogr 2003;16:777–802 (27).

AR = aortic regurgitation; cath = catheterization; echo = echocardiography; LA = left atrial/atrium; LVOT = left ventricular outflow tract; MR = mitral regurgitation.

General Recommendations

Recommendations for Echocardiography in Cardiac Murmurs

Class I

1. Echocardiography is recommended for asymptomatic patients with diastolic murmurs, continuous murmurs, holosystolic murmurs, late systolic murmurs, murmurs associated with ejection clicks or murmurs that radiate to the neck or back. (Level of Evidence: C)
2. Echocardiography is recommended for patients with heart murmurs and symptoms or signs of heart failure, myocardial ischemia/infarction, syncope, thromboembolism, infective endocarditis, or other clinical evidence of structural heart disease. (Level of Evidence: C)
3. Echocardiography is recommended for asymptomatic patients who have grade 3 or louder midpeaking systolic murmurs. (Level of Evidence: C)

Class IIa

1. Echocardiography can be useful for the evaluation of asymptomatic patients with murmurs associated with other abnormal cardiac physical findings or murmurs associated with an abnormal electrocardiogram (ECG) or chest X-ray. (Level of Evidence: C)
2. Echocardiography can be useful for patients whose symptoms and/or signs are likely noncardiac in origin but in whom a cardiac basis cannot be excluded by standard evaluation. (Level of Evidence: C)

Class III

Echocardiography is not recommended for patients who have a grade 2 or softer midsystolic murmur identified as innocent or functional by an experienced observer. (Level of Evidence: C)

Endocarditis Prophylaxis

Class I

Prophylaxis against infective endocarditis is recommended for the following patients:

- Patients with prosthetic heart valves and patients with a history of infective endocarditis. (Level of Evidence: C)
- Patients who have complex cyanotic congenital heart disease (e.g., single-ventricle states, transposition of the great arteries, tetralogy of Fallot). (Level of Evidence: C)
- Patients with surgically constructed systemic pulmonary shunts or conduits. (Level of Evidence: C)
- Patients with congenital cardiac valve malformations, particularly those with bicuspid aortic valves, and patients with acquired valvular dysfunction (e.g., rheumatic heart disease). (Level of Evidence: C)
- Patients who have undergone valve repair. (Level of Evidence: C)
- Patients who have hypertrophic cardiomyopathy when there is latent or resting obstruction. (Level of Evidence: C)

- Patients with mitral valve prolapse (MVP) and auscultatory evidence of valvular regurgitation and/or thickened leaflets on echocardiography.* (Level of Evidence: C)

Class III

Prophylaxis against infective endocarditis is not recommended for the following patients:

- Patients with isolated secundum atrial septal defect. (Level of Evidence: C)
- Patients 6 or more months after successful surgical or percutaneous repair of atrial septal defect, ventricular septal defect, or patent ductus arteriosus. (Level of Evidence: C)
- Patients with MVP without mitral regurgitation (MR) or thickened leaflets on echocardiography.* (Level of Evidence: C)
- Patients with physiological, functional, or innocent heart murmurs, including patients with aortic valve sclerosis as defined by focal areas of increased echogenicity and thickening of the leaflets without restriction of motion and a peak velocity less than 2.0 m per second. (Level of Evidence: C)
- Patients with echocardiographic evidence of physiologic MR in the absence of a murmur and with structurally normal valves. (Level of Evidence: C)
- Patients with echocardiographic evidence of physiological tricuspid regurgitation (TR) and/or pulmonary regurgitation in the absence of a murmur and with structurally normal valves. (Level of Evidence: C)

*Patients with MVP without regurgitation require additional clinical judgment. Indications for antibiotic prophylaxis in MVP are discussed in Section 3.5.2 of the original guideline document. Patients who do not have MR but who do have echocardiographic evidence of thickening and/or redundancy of the valve leaflets, and especially men 45 years of age or older, may be at increased risk for infective endocarditis. Additionally, approximately one third of patients with MVP without MR at rest may have exercise-induced MR. Some patients may exhibit MR at rest on one occasion and not on another. There are no data available to address this latter issue, and at present, the decision must be left to clinical judgment, taking into account the nature of the invasive procedure, the previous history of endocarditis, and the presence or absence of valve thickening and/or redundancy.

Rheumatic Fever Prophylaxis

Class I

Patients who have had rheumatic fever with or without carditis (including patients with mitral stenosis [MS]) should receive prophylaxis for recurrent rheumatic fever. (Level of Evidence: B)

Aortic Stenosis

Echocardiography (Imaging, Spectral, and Color Doppler) in Aortic Stenosis

Class I

1. Echocardiography is recommended for the diagnosis and assessment of aortic stenosis (AS) severity. (Level of Evidence: B)
2. Echocardiography is recommended in patients with AS for the assessment of left ventricular (LV) wall thickness, size, and function. (Level of Evidence: B)
3. Echocardiography is recommended for re-evaluation of patients with known AS and changing symptoms or signs. (Level of Evidence: B)
4. Echocardiography is recommended for the assessment of changes in hemodynamic severity and LV function in patients with known AS during pregnancy. (Level of Evidence: B)
5. Transthoracic echocardiography is recommended for re-evaluation of asymptomatic patients: every year for severe AS; every 1 to 2 years for moderate AS; and every 3 to 5 years for mild AS. (Level of Evidence: B)

Exercise Testing

Class IIb

Exercise testing in asymptomatic patients with AS may be considered to elicit exercise-induced symptoms and abnormal blood pressure responses. (Level of Evidence: B)

Class III

Exercise testing should not be performed in symptomatic patients with AS. (Level of Evidence: B)

Indications for Cardiac Catheterization

Class I

1. Coronary angiography is recommended before aortic valve replacement (AVR) in patients with AS at risk for coronary artery disease (CAD) (see Section 10.2 of the original guideline document). (Level of Evidence: B)
2. Cardiac catheterization for hemodynamic measurements is recommended for assessment of severity of AS in symptomatic patients when noninvasive tests are inconclusive or when there is a discrepancy between noninvasive tests and clinical findings regarding severity of AS. (Level of Evidence: C)
3. Coronary angiography is recommended before AVR in patients with AS for whom a pulmonary autograft (Ross procedure) is contemplated and if the origin of the coronary arteries was not identified by noninvasive technique. (Level of Evidence: C)

Class III

1. Cardiac catheterization for hemodynamic measurements is not recommended for the assessment of severity of AS before AVR when noninvasive tests are adequate and concordant with clinical findings. (Level of Evidence: C)
2. Cardiac catheterization for hemodynamic measurements is not recommended for the assessment of LV function and severity of AS in asymptomatic patients. (Level of Evidence: C)

Low-Flow/Low-Gradient Aortic Stenosis

Class IIa

1. Dobutamine stress echocardiography is reasonable to evaluate patients with low-flow/low-gradient AS and LV dysfunction. (Level of Evidence: B)
2. Cardiac catheterization for hemodynamic measurements with infusion of dobutamine can be useful for evaluation of patients with low-flow/low-gradient AS and LV dysfunction. (Level of Evidence: C)

Indications for Aortic Valve Replacement

Class I

1. AVR is indicated for symptomatic patients with severe AS.* (Level of Evidence: B)
2. AVR is indicated for patients with severe AS* undergoing coronary artery bypass graft surgery (CABG). (Level of Evidence: C)
3. AVR is indicated for patients with severe AS* undergoing surgery on the aorta or other heart valves. (Level of Evidence: C)
4. AVR is recommended for patients with severe AS* and LV systolic dysfunction (ejection fraction less than 0.50). (Level of Evidence: C)

Class IIa

AVR is reasonable for patients with moderate AS* undergoing CABG or surgery on the aorta or other heart valves (see Section 3.7 of the original guideline document on combined multiple valve disease and Section 10.4 of the original guideline document on AVR in patients undergoing CABG). (Level of Evidence: B)

Class IIb

1. AVR may be considered for asymptomatic patients with severe AS* and abnormal response to exercise (e.g., development of symptoms or asymptomatic hypotension). (Level of Evidence: C)
2. AVR may be considered for adults with severe asymptomatic AS* if there is a high likelihood of rapid progression (age, calcification, and CAD) or if surgery might be delayed at the time of symptom onset. (Level of Evidence: C)
3. AVR may be considered in patients undergoing CABG who have mild AS* when there is evidence, such as moderate to severe valve calcification, that progression may be rapid. (Level of Evidence: C)
4. AVR may be considered for asymptomatic patients with extremely severe AS (aortic valve area less than 0.6 cm^2, mean gradient greater than 60 mm Hg, and jet velocity greater than 5.0 m per second) when the patient's expected operative mortality is 1.0% or less. (Level of Evidence: C)

Class III

AVR is not useful for the prevention of sudden death in asymptomatic patients with AS who have none of the findings listed under the class IIa/IIb recommendations. (Level of Evidence: B)

*See table titled "Classification of the Severity of Valve Disease in Adults" at the beginning of these recommendations.

Aortic Balloon Valvotomy

Class IIb

1. Aortic balloon valvotomy might be reasonable as a bridge to surgery in hemodynamically unstable adult patients with AS who are at high risk for AVR. (Level of Evidence: C)
2. Aortic balloon valvotomy might be reasonable for palliation in adult patients with AS in whom AVR cannot be performed because of serious comorbid conditions. (Level of Evidence: C)

Class III

Aortic balloon valvotomy is not recommended as an alternative to AVR in adult patients with AS; certain younger adults without valve calcification may be an exception (see Section 6.1.3 of the original guideline document). (Level of Evidence: B)

Aortic Regurgitation

Diagnosis and Initial Evaluation

Class I

1. Echocardiography is indicated to confirm the presence and severity of acute or chronic AR. (Level of Evidence: B)
2. Echocardiography is indicated for diagnosis and assessment of the cause of chronic AR (including valve morphology and aortic root size and morphology) and for assessment of LV hypertrophy, dimension (or volume), and systolic function. (Level of Evidence: B)
3. Echocardiography is indicated in patients with an enlarged aortic root to assess regurgitation and the severity of aortic dilatation. (Level of Evidence: B)
4. Echocardiography is indicated for the periodic reevaluation of LV size and function in asymptomatic patients with severe AR. (Level of Evidence: B)
5. Radionuclide angiography or magnetic resonance imaging is indicated for the initial and serial assessment of LV volume and function at rest in patients with AR and suboptimal echocardiograms. (Level of Evidence: B)
6. Echocardiography is indicated to re-evaluate mild, moderate, or severe AR in patients with new or changing symptoms. (Level of Evidence: B)

Class IIa

1. Exercise stress testing for chronic AR is reasonable for assessment of functional capacity and symptomatic response in patients with a history of equivocal symptoms. (Level of Evidence: B)

2. Exercise stress testing for patients with chronic AR is reasonable for the evaluation of symptoms and functional capacity before participation in athletic activities. (Level of Evidence: C)
3. Magnetic resonance imaging is reasonable for the estimation of AR severity in patients with unsatisfactory echocardiograms. (Level of Evidence: B)

Class IIb

Exercise stress testing in patients with radionuclide angiography may be considered for assessment of LV function in asymptomatic or symptomatic patients with chronic AR. (Level of Evidence: B)

Medical Therapy

Class I

Vasodilator therapy is indicated for chronic therapy in patients with severe AR who have symptoms or LV dysfunction when surgery is not recommended because of additional cardiac or noncardiac factors. (Level of Evidence: B)

Class IIa

Vasodilator therapy is reasonable for short-term therapy to improve the hemodynamic profile of patients with severe heart failure symptoms and severe LV dysfunction before proceeding with AVR. (Level of Evidence: C)

Class IIb

Vasodilator therapy may be considered for long-term therapy in asymptomatic patients with severe AR who have LV dilatation but normal systolic function. (Level of Evidence: B)

Class III

1. Vasodilator therapy is not indicated for long-term therapy in asymptomatic patients with mild to moderate AR and normal LV systolic function. (Level of Evidence: B)
2. Vasodilator therapy is not indicated for long-term therapy in asymptomatic patients with LV systolic dysfunction who are otherwise candidates for AVR. (Level of Evidence: C)
3. Vasodilator therapy is not indicated for long-term therapy in symptomatic patients with either normal LV function or mild to moderate LV systolic dysfunction who are otherwise candidates for AVR. (Level of Evidence: C)

Indications for Cardiac Catheterization

Class I

1. Cardiac catheterization with aortic root angiography and measurement of LV pressure is indicated for assessment of severity of regurgitation, LV function,

or aortic root size when noninvasive tests are inconclusive or discordant with clinical findings in patients with AR. (Level of Evidence: B)
2. Coronary angiography is indicated before AVR in patients at risk for CAD. (Level of Evidence: C)

Class III

1. Cardiac catheterization with aortic root angiography and measurement of LV pressure is not indicated for assessment of LV function, aortic root size, or severity of regurgitation before AVR when noninvasive tests are adequate and concordant with clinical findings and coronary angiography is not needed. (Level of Evidence: C)
2. Cardiac catheterization with aortic root angiography and measurement of LV pressure is not indicated for assessment of LV function and severity of regurgitation in asymptomatic patients when noninvasive tests are adequate. (Level of Evidence: C)

Indications for Aortic Valve Replacement or Aortic Valve Repair

Class I

1. AVR is indicated for symptomatic patients with severe AR irrespective of LV systolic function. (Level of Evidence: B)
2. AVR is indicated for asymptomatic patients with chronic severe AR and LV systolic dysfunction (ejection fraction 0.50 or less) at rest. (Level of Evidence: B)
3. AVR is indicated for patients with chronic severe AR while undergoing CABG or surgery on the aorta or other heart valves. (Level of Evidence: C)

Class IIa

AVR is reasonable for asymptomatic patients with severe AR with normal LV systolic function (ejection fraction greater than 0.50) but with severe LV dilatation (end-diastolic dimension greater than 75 mm or end-systolic dimension greater than 55 mm).* (Level of Evidence: B)

Class IIb

1. AVR may be considered in patients with moderate AR while undergoing surgery on the ascending aorta. (Level of Evidence: C)
2. AVR may be considered in patients with moderate AR while undergoing CABG. (Level of Evidence: C)
3. AVR may be considered for asymptomatic patients with severe AR and normal LV systolic function at rest (ejection fraction greater than 0.50) when the degree of LV dilatation exceeds an end-diastolic dimension of 70 mm or end-systolic dimension of 50 mm, when there is evidence of progressive LV dilatation, declining exercise tolerance, or abnormal hemodynamic responses to exercise.* (Level of Evidence: C)

Class III

AVR is not indicated for asymptomatic patients with mild, moderate, or severe AR and normal LV systolic function at rest (ejection fraction greater than 0.50) when degree of dilatation is not moderate or severe (end-diastolic dimension less than 70 mm, end-systolic dimension less than 50 mm).* (Level of Evidence: B)

*Consider lower threshold values for patients of small stature of either gender.

Bicuspid Aortic Valve With Dilated Ascending Aorta

Class I

1. Patients with known bicuspid aortic valves should undergo an initial transthoracic echocardiogram to assess the diameters of the aortic root and ascending aorta. (Level of Evidence: B)
2. Cardiac magnetic resonance imaging or cardiac computed tomography is indicated in patients with bicuspid aortic valves when morphology of the aortic root or ascending aorta cannot be assessed accurately by echocardiography. (Level of Evidence: C)
3. Patients with bicuspid aortic valves and dilatation of the aortic root or ascending aorta (diameter greater than 4.0 cm*) should undergo serial evaluation of aortic root/ascending aorta size and morphology by echocardiography, cardiac magnetic resonance, or computed tomography on a yearly basis. (Level of Evidence: C)
4. Surgery to repair the aortic root or replace the ascending aorta is indicated in patients with bicuspid aortic valves if the diameter of the aortic root or ascending aorta is greater than 5.0 cm* or if the rate of increase in diameter is 0.5 cm per year or more. (Level of Evidence: C)
5. In patients with bicuspid valves undergoing AVR because of severe AS or AR (see Sections 3.1.7 and 3.2.3.8 of the original guideline document), repair of the aortic root or replacement of the ascending aorta is indicated if the diameter of the aortic root or ascending aorta is greater than 4.5 cm.* (Level of Evidence: C)

Class IIa

1. It is reasonable to give beta-adrenergic blocking agents to patients with bicuspid valves and dilated aortic roots (diameter greater than 4.0 cm*) who are not candidates for surgical correction and who do not have moderate to severe AR. (Level of Evidence: C)
2. Cardiac magnetic resonance imaging or cardiac computed tomography is reasonable in patients with bicuspid aortic valves when aortic root dilatation is detected by echocardiography to further quantify severity of dilatation and involvement of the ascending aorta. (Level of Evidence: B)

*Consider lower threshold values for patients of small stature of either gender.

Mitral Stenosis

Indications for Echocardiography in Mitral Stenosis (MS)

Class I

1. Echocardiography should be performed in patients for the diagnosis of MS, assessment of hemodynamic severity (mean gradient, mitral valve [MV] area, and pulmonary artery pressure), assessment of concomitant valvular lesions, and assessment of valve morphology (to determine suitability for percutaneous mitral balloon valvotomy). (Level of Evidence: B)
2. Echocardiography should be performed for reevaluation in patients with known MS and changing symptoms or signs. (Level of Evidence: B)
3. Echocardiography should be performed for assessment of the hemodynamic response of the mean gradient and pulmonary artery pressure by exercise Doppler echocardiography in patients with MS when there is a discrepancy between resting Doppler echocardiographic findings, clinical findings, symptoms, and signs. (Level of Evidence: C)
4. Transesophageal echocardiography in MS should be performed to assess the presence or absence of left atrial thrombus and to further evaluate the severity of MR in patients considered for percutaneous mitral balloon valvotomy. (Level of Evidence: C)
5. Transesophageal echocardiography in MS should be performed to evaluate MV morphology and hemodynamics in patients when transthoracic echocardiography provides suboptimal data. (Level of Evidence: C)

Class IIa

Echocardiography is reasonable in the re-evaluation of asymptomatic patients with MS and stable clinical findings to assess pulmonary artery pressure (for those with severe MS, every year; moderate MS, every 1 to 2 years; and mild MS, every 3 to 5 years). (Level of Evidence: C)

Class III

Transesophageal echocardiography in the patient with MS is not indicated for routine evaluation of MV morphology and hemodynamics when complete transthoracic echocardiographic data are satisfactory. (Level of Evidence: C)

Medical Therapy: Prevention of Systemic Embolization

Class I

1. Anticoagulation is indicated in patients with MS and atrial fibrillation (paroxysmal, persistent, or permanent). (Level of Evidence: B)
2. Anticoagulation is indicated in patients with MS and a prior embolic event, even in sinus rhythm. (Level of Evidence: B)
3. Anticoagulation is indicated in patients with MS with left atrial thrombus. (Level of Evidence: B)

Class IIb

1. Anticoagulation may be considered for asymptomatic patients with severe MS and left atrial dimension greater than or equal to 55 mm by echocardiography.* (Level of Evidence: B)

2. Anticoagulation may be considered for patients with severe MS, an enlarged left atrium, and spontaneous contrast on echocardiography. (Level of Evidence: C)

*This recommendation is based on a grade C level of evidence given by the American College of Chest Physicians Fourth Consensus Conference on Antithrombotic Therapy (Levine et al., 1995)

Indications for Invasive Hemodynamic Evaluation

Class I

1. Cardiac catheterization for hemodynamic evaluation should be performed for assessment of severity of MS when noninvasive tests are inconclusive or when there is discrepancy between noninvasive tests and clinical findings regarding severity of MS. (Level of Evidence: C)
2. Catheterization for hemodynamic evaluation including left ventriculography (to evaluate severity of MR) for patients with MS is indicated when there is a discrepancy between the Doppler-derived mean gradient and valve area. (Level of Evidence: C)

Class IIa

1. Cardiac catheterization is reasonable to assess the hemodynamic response of pulmonary artery and left atrial pressures to exercise when clinical symptoms and resting hemodynamics are discordant. (Level of Evidence: C)
2. Cardiac catheterization is reasonable in patients with MS to assess the cause of severe pulmonary arterial hypertension when out of proportion to severity of MS as determined by noninvasive testing. (Level of Evidence: C)

Class III

Diagnostic cardiac catheterization is not recommended to assess the MV hemodynamics when two dimensional (2D) and Doppler echocardiographic data are concordant with clinical findings. (Level of Evidence: C)

Indications for Percutaneous Mitral Balloon Valvotomy

Class I

1. Percutaneous mitral balloon valvotomy is effective for symptomatic patients (New York Heart Association [NYHA] functional class II, III, or IV), with moderate or severe MS* and valve morphology favorable for percutaneous mitral balloon valvotomy in the absence of left atrial thrombus or moderate to severe MR. (Level of Evidence: A)
2. Percutaneous mitral balloon valvotomy is effective for asymptomatic patients with moderate or severe MS* and valve morphology that is favorable for percutaneous mitral balloon valvotomy who have pulmonary hypertension (pulmonary artery systolic pressure greater than 50 mm Hg at rest or greater than 60 mm Hg with exercise) in the absence of left atrial thrombus or moderate to severe MR. (Level of Evidence: C)

Class IIa

Percutaneous mitral balloon valvotomy is reasonable for patients with moderate or severe MS* who have a nonpliable calcified valve, are in NYHA functional class III–IV, and are either not candidates for surgery or are at high risk for surgery. (Level of Evidence: C)

Class IIb

1. Percutaneous mitral balloon valvotomy may be considered for asymptomatic patients with moderate or severe MS* and valve morphology favorable for percutaneous mitral balloon valvotomy who have new onset of atrial fibrillation in the absence of left atrial thrombus or moderate to severe MR. (Level of Evidence: C)
2. Percutaneous mitral balloon valvotomy may be considered for symptomatic patients (NYHA functional class II, III, or IV) with MV area greater than 1.5 cm^2 if there is evidence of hemodynamically significant MS based on pulmonary artery systolic pressure greater than 60 mm Hg, pulmonary artery wedge pressure of 25 mm Hg or more, or mean MV gradient greater than 15 mm Hg during exercise. (Level of Evidence: C)
3. Percutaneous mitral balloon valvotomy may be considered as an alternative to surgery for patients with moderate or severe MS who have a nonpliable calcified valve and are in NYHA class III–IV. (Level of Evidence: C)

Class III

1. Percutaneous mitral balloon valvotomy is not indicated for patients with mild MS. (Level of Evidence: C)
2. Percutaneous mitral balloon valvotomy should not be performed in patients with moderate to severe MR or left atrial thrombus. (Level of Evidence: C)

*See table titled "Classification of the Severity of Valve Disease in Adults" at the beginning of these recommendations.

Indications for Surgery for Mitral Stenosis

Class I

1. MV surgery (repair if possible) is indicated in patients with symptomatic (NYHA functional class III–IV) moderate or severe MS* when 1) percutaneous mitral balloon valvotomy is unavailable, 2) percutaneous mitral balloon valvotomy is contraindicated because of left atrial thrombus despite anticoagulation or because concomitant moderate to severe MR is present, or 3) the valve morphology is not favorable for percutaneous mitral balloon valvotomy in a patient with acceptable operative risk. (Level of Evidence: B)
2. Symptomatic patients with moderate to severe MS* who also have moderate to severe MR should receive MV replacement, unless valve repair is possible at the time of surgery. (Level of Evidence: C)

Class IIa

MV replacement is reasonable for patients with severe MS* and severe pulmonary hypertension (pulmonary artery systolic pressure greater than 60 mm Hg) with NYHA functional class I–II symptoms who are not considered candidates for percutaneous mitral balloon valvotomy or surgical MV repair. (Level of Evidence: C)

Class IIb

MV repair may be considered for asymptomatic patients with moderate or severe MS* who have had recurrent embolic events while receiving adequate anticoagulation and who have valve morphology favorable for repair. (Level of Evidence: C)

Class III

1. MV repair for MS is not indicated for patients with mild MS. (Level of Evidence: C)
2. Closed commissurotomy should not be performed in patients undergoing MV repair; open commissurotomy is the preferred approach. (Level of Evidence: C)

*See table titled "Classification of the Severity of Valve Disease in Adults" at the beginning of these recommendations.

Mitral Valve Prolapse (MVP)

Evaluation and Management of the Asymptomatic Patient

Class I

Echocardiography is indicated for the diagnosis of MVP and assessment of MR, leaflet morphology, and ventricular compensation in asymptomatic patients with physical signs of MVP. (Level of Evidence: B)

Class IIa

1. Echocardiography can effectively exclude MVP in asymptomatic patients who have been diagnosed without clinical evidence to support the diagnosis. (Level of Evidence: C)
2. Echocardiography can be effective for risk stratification in asymptomatic patients with physical signs of MVP or known MVP. (Level of Evidence: C)

Class III

1. Echocardiography is not indicated to exclude MVP in asymptomatic patients with ill-defined symptoms in the absence of a constellation of clinical symptoms or physical findings suggestive of MVP or a positive family history. (Level of Evidence: B)
2. Routine repetition of echocardiography is not indicated for the asymptomatic patient who has MVP and no MR or MVP and mild MR with no changes in clinical signs or symptoms. (Level of Evidence: C)

Evaluation and Management of the Symptomatic Patient

Class I

1. Aspirin therapy (75 to 325 mg per day) is recommended for symptomatic patients with MVP who experience cerebral transient ischemic attacks. (Level of Evidence: C)
2. In patients with MVP and atrial fibrillation, warfarin therapy is recommended for patients aged greater than 65 or those with hypertension, MR murmur, or a history of heart failure. (Level of Evidence: C)
3. Aspirin therapy (75 to 325 mg per day) is recommended for patients with MVP and atrial fibrillation who are less than 65 years old and have no history of MR, hypertension, or heart failure. (Level of Evidence: C)
4. In patients with MVP and a history of stroke, warfarin therapy is recommended for patients with MR, atrial fibrillation or left atrial thrombus. (Level of Evidence: C)

Class IIa

1. In patients with MVP and a history of stroke, who do not have MR, atrial fibrillation or left atrial thrombus, warfarin therapy is reasonable for patients with echocardiographic evidence of thickening (5mm or greater) and/or redundancy of the valve leaflets. (Level of Evidence: C)
2. In patients with MVP and a history of stroke, aspirin therapy is reasonable for patients who do not have MR, atrial fibrillation, left atrial thrombus, or echocardiographic evidence of thickening (5 mm or greater) or redundancy of the valve leaflets. (Level of Evidence: C)
3. Warfarin therapy is reasonable for patients with MVP with transient ischemic attacks despite aspirin therapy. (Level of Evidence: C)
4. Aspirin therapy (75 to 325 mg per day) can be beneficial for patients with MVP and a history of stroke who have contraindications to anticoagulants. (Level of Evidence: B)

Class IIb

Aspirin therapy (75 to 325 mg per day) may be considered for patients in sinus rhythm with echocardiographic evidence of high-risk MVP. (Level of Evidence: C)

<u>Mitral Regurgitations</u>

Indications for Transthoracic Echocardiography

Class I

1. Transthoracic echocardiography is indicated for baseline evaluation of LV size and function, right ventricular (RV) and left atrial size, pulmonary artery pressure, and severity of MR* in any patient suspected of having MR. (Level of Evidence: C)
2. Transthoracic echocardiography is indicated for delineation of the mechanism of MR. (Level of Evidence: B)

3. Transthoracic echocardiography is indicated for annual or semiannual surveillance of LV function (estimated by ejection fraction and end-systolic dimension) in asymptomatic patients with moderate to severe MR. (Level of Evidence: C)
4. Transthoracic echocardiography is indicated in patients with MR to evaluate the MV apparatus and LV function after a change in signs or symptoms. (Level of Evidence: C)
5. Transthoracic echocardiography is indicated to evaluate LV size and function and MV hemodynamics in the initial evaluation after MV replacement or MV repair. (Level of Evidence: C)

Class IIa

Exercise Doppler echocardiography is reasonable in asymptomatic patients with severe MR to assess exercise tolerance and the effects of exercise on pulmonary artery pressure and MR severity. (Level of Evidence: C)

Class III

Transthoracic echocardiography is not indicated for routine follow-up evaluation of asymptomatic patients with mild MR and normal LV size and systolic function. (Level of Evidence: C)

*See table titled "Classification of the Severity of Valve Disease in Adults" at the beginning of these recommendations

Indications for Transesophageal Echocardiography (see also Section 8.1.4 of the original guideline document)

Class I

1. Preoperative or intraoperative transesophageal echocardiography is indicated to establish the anatomic basis for severe MR in patients in whom surgery is recommended to assess feasibility of repair and to guide repair. (Level of Evidence: B)
2. Transesophageal echocardiography is indicated for evaluation of MR patients in whom transthoracic echocardiography provides nondiagnostic information regarding severity of MR, mechanism of MR, and/or status of LV function. (Level of Evidence: B)

Class IIa

Preoperative transesophageal echocardiography is reasonable in asymptomatic patients with severe MR who are considered for surgery to assess feasibility of repair. (Level of Evidence: C)

Class III

Transesophageal echocardiography is not indicated for routine follow-up or surveillance of asymptomatic patients with native valve MR. (Level of Evidence: C)

Indications for Cardiac Catheterization

Class I

1. Left ventriculography and hemodynamic measurements are indicated when noninvasive tests are inconclusive regarding severity of MR, LV function, or the need for surgery. (Level of Evidence: C)
2. Hemodynamic measurements are indicated when pulmonary artery pressure is out of proportion to the severity of MR as assessed by noninvasive testing. (Level of Evidence: C)
3. Left ventriculography and hemodynamic measurements are indicated when there is a discrepancy between clinical and noninvasive findings regarding severity of MR. (Level of Evidence: C)
4. Coronary angiography is indicated before MV repair or MV replacement in patients at risk for CAD. (Level of Evidence: C)

Class III

Left ventriculography and hemodynamic measurements are not indicated in patients with MR in whom valve surgery is not contemplated. (Level of Evidence: C)

Indications for Mitral Valve Operation

Class I

1. MV surgery is recommended for the symptomatic patient with acute severe MR.* (Level of Evidence: B)
2. MV surgery is beneficial for patients with chronic severe MR* and NYHA functional class II, III, or IV symptoms in the absence of severe LV dysfunction (severe LV dysfunction is defined as ejection fraction less than 0.30) and/or end-systolic dimension greater than 55 mm. (Level of Evidence: B)
3. MV surgery is beneficial for asymptomatic patients with chronic severe MR* and mild to moderate LV dysfunction, ejection fraction 0.30 to 0.60, and/or end-systolic dimension greater than or equal to 40 mm. (Level of Evidence: B)
4. MV repair is recommended over MV replacement in the majority of patients with severe chronic MR* who require surgery, and patients should be referred to surgical centers experienced in MV repair. (Level of Evidence: C)

Class IIa

1. MV repair is reasonable in experienced surgical centers for asymptomatic patients with chronic severe MR* with preserved LV function (ejection fraction greater than 0.60 and end-systolic dimension less than 40 mm) in whom the likelihood of successful repair without residual MR is greater than 90%. (Level of Evidence: B)
2. MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and new onset of atrial fibrillation. (Level of Evidence: C)

3. MV surgery is reasonable for asymptomatic patients with chronic severe MR,* preserved LV function, and pulmonary hypertension (pulmonary artery systolic pressure greater than 50 mm Hg at rest or greater than 60 mm Hg with exercise). (Level of Evidence: C)
4. MV surgery is reasonable for patients with chronic severe MR* due to a primary abnormality of the mitral apparatus and NYHA functional class III–IV symptoms and severe LV dysfunction (ejection fraction less than 0.30 and/or end-systolic dimension greater than 55 mm) in whom MV repair is highly likely. (Level of Evidence: C)

Class IIb

MV repair may be considered for patients with chronic severe secondary MR* due to severe LV dysfunction (ejection fraction less than 0.30) who have persistent NYHA functional class III-IV symptoms despite optimal therapy for heart failure, including biventricular pacing. (Level of Evidence: C)

Class III

1. MV surgery is not indicated for asymptomatic patients with MR and preserved LV function (ejection fraction greater than 0.60 and end-systolic dimension less than 40 mm) in whom significant doubt about the feasibility of repair exists. (Level of Evidence: C)
2. Isolated MV surgery is not indicated for patients with mild or moderate MR. (Level of Evidence: C)

*See table titled "Classification of the Severity of Valve Disease in Adults" at the beginning of these recommendations.

Multiple Valve Disease

Management of Tricuspid Valve Disease

Class I

Tricuspid valve repair is beneficial for severe tricuspid regurgitation (TR) in patients with MV disease requiring MV surgery. (Level of Evidence: B)

Class IIa

1. Tricuspid valve replacement or annuloplasty is reasonable for severe primary TR when symptomatic. (Level of Evidence: C)
2. Tricuspid valve replacement is reasonable for severe TR secondary to diseased/abnormal tricuspid valve leaflets not amenable to annuloplasty or repair. (Level of Evidence: C)

Class IIb

Tricuspid annuloplasty may be considered for less than severe TR in patients undergoing MV surgery when there is pulmonary hypertension or tricuspid annular dilatation. (Level of Evidence: C)

Class III

1. Tricuspid valve replacement or annuloplasty is not indicated in asymptomatic patients with TR whose pulmonary artery systolic pressure is less than 60 mm Hg in the presence of a normal MV. (Level of Evidence: C)
2. Tricuspid valve replacement or annuloplasty is not indicated in patients with mild primary TR. (Level of Evidence: C)

Infective Endocarditis

Evaluation and Management

Class I

Patients at risk for infective endocarditis who have unexplained fever for more than 48 hours (h) should have at least 2 sets of blood cultures obtained from different sites. (Level of Evidence: B)

Class III

Patients with known valve disease or a valve prosthesis should not receive antibiotics before blood cultures are obtained for unexplained fever. (Level of Evidence: C)

Transthoracic Echocardiography in Endocarditis

Class I

1. Transthoracic echocardiography to detect valvular vegetations with or without positive blood cultures is recommended for the diagnosis of infective endocarditis. (Level of Evidence: B)
2. Transthoracic echocardiography is recommended to characterize the hemodynamic severity of valvular lesions in known infective endocarditis. (Level of Evidence: B)
3. Transthoracic echocardiography is recommended for assessment of complications of infective endocarditis (e.g., abscesses, perforation, and shunts). (Level of Evidence: B)
4. Transthoracic echocardiography is recommended for reassessment of high-risk patients (e.g., those with a virulent organism, clinical deterioration, persistent or recurrent fever, new murmur, or persistent bacteremia). (Level of Evidence: C)

Class IIa

Transthoracic echocardiography is reasonable to diagnose infective endocarditis of a prosthetic valve in the presence of persistent fever without bacteremia or a new murmur. (Level of Evidence: C)

Class IIb

Transthoracic echocardiography may be considered for the re-evaluation of prosthetic valve endocarditis during antibiotic therapy in the absence of clinical deterioration. (Level of Evidence: C)

Class III

Transthoracic echocardiography is not indicated to re-evaluate uncomplicated (including no regurgitation on baseline echocardiogram) native valve endocarditis during antibiotic treatment in the absence of clinical deterioration, new physical findings or persistent fever. (Level of Evidence: C)

Transesophageal Echocardiography in Endocarditis

Class I

1. Transesophageal echocardiography is recommended to assess the severity of valvular lesions in symptomatic patients with infective endocarditis, if transthoracic echocardiography is nondiagnostic. (Level of Evidence: C)
2. Transesophageal echocardiography is recommended to diagnose infective endocarditis in patients with valvular heart disease and positive blood cultures, if transthoracic echocardiography is nondiagnostic. (Level of Evidence: C)
3. Transesophageal echocardiography is recommended to diagnose complications of infective endocarditis with potential impact on prognosis and management (e.g., abscesses, perforation, and shunts). (Level of Evidence: C)
4. Transesophageal echocardiography is recommended as first-line diagnostic study to diagnose prosthetic valve endocarditis and assess for complications. (Level of Evidence: C)
5. Transesophageal echocardiography is recommended for preoperative evaluation in patients with known infective endocarditis, unless the need for surgery is evident on transthoracic imaging and unless preoperative imaging will delay surgery in urgent cases. (Level of Evidence: C)
6. Intraoperative transesophageal echocardiography is recommended for patients undergoing valve surgery for infective endocarditis. (Level of Evidence: C)

Class IIa

Transesophageal echocardiography is reasonable to diagnose possible infective endocarditis in patients with persistent staphylococcal bacteremia without a known source. (Level of Evidence: C)

Class IIb

Transesophageal echocardiography might be considered to detect infective endocarditis in patients with nosocomial staphylococcal bacteremia. (Level of Evidence: C)

Surgery for Native Valve Endocarditis

Class I

1. Surgery of the native valve is indicated in patients with acute infective endocarditis who present with valve stenosis or regurgitation resulting in heart failure. (Level of Evidence: B)
2. Surgery of the native valve is indicated in patients with acute infective endocarditis who present with AR or MR with hemodynamic evidence of elevated LV end-diastolic or left atrial pressures (e.g., premature closure of MV with AR, rapid decelerating MR signal by continuous-wave Doppler (v-wave cutoff sign), or moderate or severe pulmonary hypertension). (Level of Evidence: B)
3. Surgery of the native valve is indicated in patients with infective endocarditis caused by fungal or other highly resistant organisms. (Level of Evidence: B)
4. Surgery of the native valve is indicated in patients with infective endocarditis complicated by heart block, annular or aortic abscess, or destructive penetrating lesions (e.g., sinus of Valsalva to right atrium, right ventricle, or left atrium fistula; mitral leaflet perforation with aortic valve endocarditis; or infection in annulus fibrosa). (Level of Evidence: B)

Class IIa

Surgery of the native valve is reasonable in patients with infective endocarditis who present with recurrent emboli and persistent vegetations despite appropriate antibiotic therapy. (Level of Evidence: C)

Class IIb

Surgery of the native valve may be considered in patients with infective endocarditis who present with mobile vegetations in excess of 10 mm with or without emboli. (Level of Evidence: C)

Surgery for Prosthetic Valve Endocarditis

Class I

1. Consultation with a cardiac surgeon is indicated for patients with infective endocarditis of a prosthetic valve. (Level of Evidence: C)
2. Surgery is indicated for patients with infective endocarditis of a prosthetic valve who present with heart failure. (Level of Evidence: B)
3. Surgery is indicated for patients with infective endocarditis of a prosthetic valve who present with dehiscence evidenced by cine fluoroscopy or echocardiography. (Level of Evidence: B)
4. Surgery is indicated for patients with infective endocarditis of a prosthetic valve who present with evidence of increasing obstruction or worsening regurgitation. (Level of Evidence: C)
5. Surgery is indicated for patients with infective endocarditis of a prosthetic valve who present with complications, for example, abscess formation. (Level of Evidence: C)

Class IIa

1. Surgery is reasonable for patients with infective endocarditis of a prosthetic valve who present with evidence of persistent bacteremia or recurrent emboli despite appropriate antibiotic treatment. (Level of Evidence: C)
2. Surgery is reasonable for patients with infective endocarditis of a prosthetic valve who present with relapsing infection. (Level of Evidence: C)

Class III

Routine surgery is not indicated for patients with uncomplicated infective endocarditis of a prosthetic valve caused by first infection with a sensitive organism. (Level of Evidence: C)

Management of Valvular Disease in Pregnancy

Selection of Anticoagulation Regimen in Pregnant Patients With Mechanical Prosthetic Valves

Class I

1. All pregnant patients with mechanical prosthetic valves must receive continuous therapeutic anticoagulation with frequent monitoring (see Section 9.2 of the original guideline document). (Level of Evidence: B)
2. For women requiring long-term warfarin therapy who are attempting pregnancy, pregnancy tests should be monitored with discussions about subsequent anticoagulation therapy, so that anticoagulation can be continued uninterrupted when pregnancy is achieved. (Level of Evidence: C)
3. Pregnant patients with mechanical prosthetic valves who elect to stop warfarin between weeks 6 and 12 of gestation should receive continuous intravenous unfractionated heparin (UFH), dose-adjusted UFH, or dose-adjusted subcutaneous low molecular weight heparin (LMWH). (Level of Evidence: C)
4. For pregnant patients with mechanical prosthetic valves, up to 36 weeks of gestation, the therapeutic choice of continuous intravenous or dose-adjusted subcutaneous UFH, dose-adjusted LMWH, or warfarin should be discussed fully. If continuous intravenous UFH is used, the fetal risk is lower, but the maternal risks of prosthetic valve thrombosis, systemic embolization, infection, osteoporosis, and heparin-induced thrombocytopenia are relatively higher. (Level of Evidence: C)
5. In pregnant patients with mechanical prosthetic valves who receive dose-adjusted LMWH, the LMWH should be administered twice daily subcutaneously to maintain the anti-Xa level between 0.7 and 1.2 units (U) per ml 4 h after administration. (Level of Evidence: C)
6. In pregnant patients with mechanical prosthetic valves who receive dose-adjusted UFH, the activated partial thromboplastin time (aPTT) should be at least twice control. (Level of Evidence: C)
7. In pregnant patients with mechanical prosthetic valves who receive warfarin, the international normalized ratio (INR) goal should be 3.0 (range 2.5 to 3.5). (Level of Evidence: C)
8. In pregnant patients with mechanical prosthetic valves, warfarin should be discontinued and continuous intravenous UFH given starting 2 to 3 weeks before planned delivery. (Level of Evidence: C)

Class IIa

1. In patients with mechanical prosthetic valves, it is reasonable to avoid warfarin between weeks 6 and 12 of gestation owing to the high risk of fetal defects. (Level of Evidence: C)
2. In patients with mechanical prosthetic valves, it is reasonable to resume UFH 4 to 6 h after delivery and begin oral warfarin in the absence of significant bleeding. (Level of Evidence: C)
3. In patients with mechanical prosthetic valves, it is reasonable to give low-dose aspirin (75 to 100 mg per day) in the second and third trimesters of pregnancy in addition to anticoagulation with warfarin or heparin. (Level of Evidence: C)

Class III

1. LMWH should not be administered to pregnant patients with mechanical prosthetic valves unless anti-Xa levels are monitored 4 to 6 h after administration. (Level of Evidence: C)
2. Dipyridamole should not be used instead of aspirin as an alternative antiplatelet agent in pregnant patients with mechanical prosthetic valves because of its harmful effects on the fetus. (Level of Evidence: B)

Management of Congenital Valvular Heart Disease in Adolescents and Young Adults

Evaluation of Asymptomatic Adolescents or Young Adults With Aortic Stenosis

Class I

1. An ECG is recommended yearly in the asymptomatic adolescent or young adult with AS who has a Doppler mean gradient greater than 30 mm Hg or a peak velocity greater than 3.5 m per second (peak gradient greater than 50 mm Hg) and every 2 years if the echocardiographic Doppler mean gradient is less than or equal to 30 mm Hg or the peak velocity is less than or equal to 3.5 m per second (peak gradient less than or equal to 50 mm Hg). (Level of Evidence C)
2. Doppler echocardiography is recommended yearly in the asymptomatic adolescent or young adult with AS who has a Doppler mean gradient greater than 30 mm Hg or a peak velocity greater than 3.5 m per second (peak gradient greater than 50 mm Hg) and every 2 years if the Doppler gradient is less than or equal to 30 mm Hg or the peak jet velocity is less than or equal to 3.5 m per second (peak gradient less than or equal to 50 mm Hg). (Level of Evidence C)
3. Cardiac catheterization for the evaluation of AS is an effective diagnostic tool in the asymptomatic adolescent or young adult when results of Doppler echocardiography are equivocal regarding severity of AS or when there is a discrepancy between clinical and noninvasive findings regarding severity of AS. (Level of Evidence: C)
4. Cardiac catheterization is indicated in the adolescent or young adult with AS who has symptoms of angina, syncope, or dyspnea on exertion if the Doppler mean gradient is greater than 30 mm Hg or the peak velocity is greater than

3.5 m per second (peak gradient greater than 50 mm Hg). (Level of Evidence C)
5. Cardiac catheterization is indicated in the asymptomatic adolescent or young adult with AS who develops T-wave inversion at rest over the left precordium if the Doppler mean gradient is greater than 30 mm Hg or the peak velocity is greater than 3.5 m per second (peak gradient greater than 50 mm Hg). (Level of Evidence C)

Class IIa

1. Graded exercise testing is a reasonable diagnostic evaluation in the adolescent or young adult with AS who has a Doppler mean gradient greater than 30 mm Hg or a peak velocity greater than 3.5 m per second (peak gradient greater than 50 mm Hg) if the patient is interested in athletic participation, or if the clinical findings and Doppler findings are disparate. (Level of Evidence: C)
2. Cardiac catheterization for the evaluation of AS is a reasonable diagnostic tool in the asymptomatic adolescent or young adult who has a Doppler mean gradient greater than 40 mm Hg or a peak velocity greater than 4 m per second (peak gradient greater than 64 mm Hg). (Level of Evidence C)
3. Cardiac catheterization for the evaluation of AS is reasonable in the adolescent or young adult who has a Doppler mean gradient greater than 30 mm Hg or a peak velocity greater than 3.5 m per second (peak gradient greater than 50 mm Hg) if the patient is interested in athletic participation or becoming pregnant, or if the clinical findings and Doppler echocardiographic findings are disparate. (Level of Evidence C)

Indications for Aortic Balloon Valvotomy in Adolescents and Young Adults

Class I

1. Aortic balloon valvotomy is indicated in the adolescent or young adult patient with AS who has symptoms of angina, syncope, or dyspnea on exertion and a catheterization peak LV–to–peak aortic gradient greater than or equal to 50 mm Hg without a heavily calcified valve. (Level of Evidence: C)*
2. Aortic balloon valvotomy is indicated for the asymptomatic adolescent or young adult patient with AS who has a catheterization peak LV–to–peak aortic gradient greater than 60 mm Hg. (Level of Evidence: C)*
3. Aortic balloon valvotomy is indicated in the asymptomatic adolescent or young adult patient with AS who develops ST or T-wave changes over the left precordium on ECG at rest or with exercise and who has a catheterization peak LV–to–aortic gradient greater than 50 mm Hg. (Level of Evidence: C)*

Class IIa

1. Aortic balloon valvotomy is reasonable in the asymptomatic adolescent or young adult patient with AS when catheterization peak LV–to–peak aortic gradient is greater than 50 mm Hg and the patient wants to play competitive sports or desires to become pregnant. (Level of Evidence: C)*
2. In the adolescent or young adult patient with AS, aortic balloon valvotomy is probably recommended over valve surgery when balloon valvotomy is

possible. Patients should be referred to a center with expertise in balloon valvotomy. (Level of Evidence: C)*

Class III

Aortic balloon valvotomy should not be performed when the asymptomatic adolescent or young adult patient with AS has a catheterization peak LV–to–peak aortic gradient less than 40 mm Hg without symptoms or ECG changes. (Level of Evidence: C)*

*Gradients are usually obtained with patients sedated. If general anesthesia is used, the gradients may be somewhat lower.

Aortic Regurgitation (AR)

Class I

1. An adolescent or young adult with chronic severe AR* with onset of symptoms of angina, syncope, or dyspnea on exertion should receive aortic valve repair or replacement. (Level of Evidence: C)
2. Asymptomatic adolescent or young adult patients with chronic severe AR* with LV systolic dysfunction (ejection fraction less than 0.50) on serial studies 1 to 3 months apart should receive aortic valve repair or replacement. (Level of Evidence: C)
3. Asymptomatic adolescent or young adult patients with chronic severe AR* with progressive LV enlargement (end-diastolic dimension greater than 4 standard deviations above normal) should receive aortic valve repair or replacement. (Level of Evidence: C)
4. Coronary angiography is recommended before AVR in adolescent or young adult patients with AR in whom a pulmonary autograft (Ross operation) is contemplated when the origin of the coronary arteries has not been identified by noninvasive techniques. (Level of Evidence: C)

Class IIb

1. An asymptomatic adolescent with chronic severe AR* with moderate AS (peak LV–to–peak aortic gradient greater than 40 mm Hg at cardiac catheterization) may be considered for aortic valve repair or replacement. (Level of Evidence: C)
2. An asymptomatic adolescent with chronic severe AR* with onset of ST depression or T-wave inversion over the left precordium on ECG at rest may be considered for aortic valve repair or replacement. (Level of Evidence: C)

*See table titled "Classification of the Severity of Valve Disease in Adults" at the beginning of these recommendations.

Mitral Regurgitation

Class I

1. MV surgery is indicated in the symptomatic adolescent or young adult with severe congenital MR* with NYHA functional class III or IV symptoms. (Level of Evidence: C)
2. MV surgery is indicated in the asymptomatic adolescent or young adult with severe congenital MR* and LV systolic dysfunction (ejection fraction less than or equal to 0.60). (Level of Evidence: C)

Class IIa

MV repair is reasonable in experienced surgical centers in the asymptomatic adolescent or young adult with severe congenital MR* with preserved LV systolic function if the likelihood of successful repair without residual MR is greater than 90%. (Level of Evidence: B)

Class IIb

The effectiveness of MV surgery is not well established in asymptomatic adolescent or young adult patients with severe congenital MR* and preserved LV systolic function in whom valve replacement is highly likely. (Level of Evidence: C)

*See table titled "Classification of the Severity of Valve Disease in Adults" at the beginning of these recommendations.

Mitral Stenosis

Class I

MV surgery is indicated in adolescent or young adult patients with congenital MS who have symptoms (NYHA functional class III or IV) and mean MV gradient greater than 10 mm Hg on Doppler echocardiography.* (Level of Evidence: C)

Class IIa

1. MV surgery is reasonable in adolescent or young adult patients with congenital MS who have mild symptoms (NYHA functional class II) and mean MV gradient greater than 10 mm Hg on Doppler echocardiography.* (Level of Evidence: C)
2. MV surgery is reasonable in the asymptomatic adolescent or young adult with congenital MS with pulmonary artery systolic pressure 50 mm Hg or greater and a mean MV gradient greater than or equal to 10 mm Hg.* (Level of Evidence: C)

Class IIb

The effectiveness of MV surgery is not well established in the asymptomatic adolescent or young adult with congenital MS and new-onset atrial fibrillation or multiple systemic emboli while receiving adequate anticoagulation.* (Level of Evidence: C)

*See table titled "Classification of the Severity of Valve Disease in Adults" at the beginning of these recommendations.

Evaluation of Tricuspid Valve Disease in Adolescents and Young Adults

Class I

1. An ECG is indicated for the initial evaluation of adolescent and young adult patients with TR, and serially every 1 to 3 years, depending on severity. (Level of Evidence: C)
2. Chest X-ray is indicated for the initial evaluation of adolescent and young adult patients with TR, and serially every 1 to 3 years, depending on severity. (Level of Evidence: C)
3. Doppler echocardiography is indicated for the initial evaluation of adolescent and young adult patients with TR, and serially every 1 to 3 years, depending on severity. (Level of Evidence: C)
4. Pulse oximetry at rest and/or during exercise is indicated for the initial evaluation of adolescent and young adult patients with TR if an atrial communication is present, and serially every 1 to 3 years, depending on severity. (Level of Evidence: C)

Class IIa

1. If there is a symptomatic atrial arrhythmia, an electrophysiology study can be useful for the initial evaluation of adolescent and young adult patients with TR. (Level of Evidence: C)
2. Exercise testing is reasonable for the initial evaluation of adolescent and young adult patients with TR, and serially every 1 to 3 years. (Level of Evidence: C)

Class IIb

Holter monitoring may be considered for the initial evaluation of asymptomatic adolescent and young adult patients with TR, and serially every 1 to 3 years. (Level of Evidence: C)

Indications for Intervention in Tricuspid Regurgitation

Class I

1. Surgery for severe TR is recommended for adolescent and young adult patients with deteriorating exercise capacity (NYHA functional class III or IV). (Level of Evidence: C)
2. Surgery for severe TR is recommended for adolescent and young adult patients with progressive cyanosis and arterial saturation less than 80% at rest or with exercise. (Level of Evidence: C)
3. Interventional catheterization closure of the atrial communication is recommended for the adolescent or young adult with TR who is hypoxemic at rest and with exercise intolerance due to increasing hypoxemia with exercise, when the tricuspid valve appears difficult to repair surgically. (Level of Evidence: C)

Class IIa

1. Surgery for severe TR is reasonable in adolescent and young adult patients with NYHA functional class II symptoms if the valve appears to be repairable. (Level of Evidence: C)
2. Surgery for severe TR is reasonable in adolescent and young adult patients with atrial fibrillation. (Level of Evidence: C)

Class IIb

1. Surgery for severe TR may be considered in asymptomatic adolescent and young adult patients with increasing heart size and a cardiothoracic ratio of more than 65%. (Level of Evidence: C)
2. Surgery for severe TR may be considered in asymptomatic adolescent and young adult patients with stable heart size and an arterial saturation of less than 85% when the tricuspid valve appears repairable. (Level of Evidence: C)
3. In adolescent and young adult patients with TR who are mildly cyanotic at rest but who become very hypoxemic with exercise, closure of the atrial communication by interventional catheterization may be considered when the valve does not appear amenable to repair. (Level of Evidence: C)
4. If surgery for Ebstein's anomaly is planned in adolescent and young adult patients (tricuspid valve repair or replacement), a preoperative electrophysiological study may be considered to identify accessory pathways. If present, these may be considered for mapping and ablation either preoperatively or at the time of surgery. (Level of Evidence: C)

Evaluation of Pulmonic Stenosis in Adolescents and Young Adults

Class I

1. An ECG is recommended for the initial evaluation of pulmonic stenosis in adolescent and young adult patients, and serially every 5 to 10 years for follow-up examinations. (Level of Evidence: C)
2. Transthoracic Doppler echocardiography is recommended for the initial evaluation of pulmonic stenosis in adolescent and young adult patients, and serially every 5 to 10 years for follow-up examinations. (Level of Evidence: C)
3. Cardiac catheterization is recommended in the adolescent or young adult with pulmonic stenosis for evaluation of the valvular gradient if the Doppler peak jet velocity is greater than 3 m per second (estimated peak gradient greater than 36 mm Hg) and balloon dilation can be performed if indicated. (Level of Evidence: C)

Class III

Diagnostic cardiac catheterization is not recommended for the initial diagnostic evaluation of pulmonic stenosis in adolescent and young adult patients. (Level of Evidence: C)

Indications for Balloon Valvotomy in Pulmonic Stenosis

Class I

1. Balloon valvotomy is recommended in adolescent and young adult patients with pulmonic stenosis who have exertional dyspnea, angina, syncope, or presyncope and an RV–to–pulmonary artery peak-to-peak gradient greater than 30 mm Hg at catheterization. (Level of Evidence: C)
2. Balloon valvotomy is recommended in asymptomatic adolescent and young adult patients with pulmonic stenosis and RV–to–pulmonary artery peak-to-peak gradient greater than 40 mm Hg at catheterization. (Level of Evidence: C)

Class IIb

Balloon valvotomy may be reasonable in asymptomatic adolescent and young adult patients with pulmonic stenosis and an RV–to–pulmonary artery peak-to-peak gradient 30 to 39 mm Hg at catheterization. (Level of Evidence: C)

Class III

Balloon valvotomy is not recommended in asymptomatic adolescent and young adult patients with pulmonic stenosis and RV–to–pulmonary artery peak-to-peak gradient less than 30 mm Hg at catheterization. (Level of Evidence: C)

Surgical Considerations

Major Criteria for Aortic Valve Selection

Class I

1. A mechanical prosthesis is recommended for AVR in patients with a mechanical valve in the mitral or tricuspid position. (Level of Evidence: C)
2. A bioprosthesis is recommended for AVR in patients of any age who will not take warfarin or who have major medical contraindications to warfarin therapy. (Level of Evidence: C)

Class IIa

1. Patient preference is a reasonable consideration in the selection of aortic valve operation and valve prosthesis. A mechanical prosthesis is reasonable for AVR in patients under 65 years of age who do not have a contraindication to anticoagulation. A bioprosthesis is reasonable for AVR in patients under 65 years of age who elect to receive this valve for lifestyle considerations after detailed discussions of the risks of anticoagulation versus the likelihood that a second AVR may be necessary in the future. (Level of Evidence: C)
2. A bioprosthesis is reasonable for AVR in patients aged 65 years or older without risk factors for thromboembolism. (Level of Evidence: C)
3. Aortic valve re-replacement with a homograft is reasonable for patients with active prosthetic valve endocarditis. (Level of Evidence: C)

Class IIb

A bioprosthesis might be considered for AVR in a woman of childbearing age (see Sections 5.7 and 5.8 of the original guideline document). (Level of Evidence: C)

Myxomatous Mitral Valve

Class I

1. MV repair is recommended when anatomically possible for patients with severe degenerative MR who fulfill clinical indications, and patients should be referred to surgeons who are expert in repair. (Level of Evidence: B)
2. Patients who have undergone successful MV repair should continue to receive antibiotics as indicated for endocarditis prophylaxis. (Level of Evidence: C)
3. Patients who have undergone successful MV repair and have chronic or paroxysmal atrial fibrillation should continue to receive long-term anticoagulation with warfarin. (Level of Evidence: B)
4. Patients who have undergone successful MV repair should undergo 2D and Doppler echocardiography before discharge or at the first postoperative outpatient visit. (Level of Evidence: C)
5. Tricuspid valve repair is beneficial for severe TR in patients with MV disease that requires MV surgery. (Level of Evidence: B)

Class IIa

1. Oral anticoagulation is reasonable for the first 3 months after MV repair. (Level of Evidence: C)
2. Long-term treatment with low-dose aspirin (75 to 100 mg per day) is reasonable in patients who have undergone successful MV repair and remain in sinus rhythm. (Level of Evidence: C)
3. Tricuspid annuloplasty is reasonable for mild TR in patients undergoing MV repair when there is pulmonary hypertension or tricuspid annular dilatation. (Level of Evidence: C)

Class IIb

In patients with MR and a history of atrial fibrillation, a Maze procedure may be considered at the time of MV repair. (Level of Evidence: B)

Rheumatic Heart Disease

Class I

Percutaneous or surgical MV commissurotomy is indicated when anatomically possible for treatment of severe MS, when clinically indicated. (Level of Evidence: C)

Selection of a Mitral Valve Prosthesis

Class I

A bioprosthesis is indicated for MV replacement in a patient who will not take warfarin, is incapable of taking warfarin, or has a clear contraindication to warfarin therapy. (Level of Evidence: C)

Class IIa

1. A mechanical prosthesis is reasonable for MV replacement in patients under 65 years of age with long-standing atrial fibrillation. (Level of Evidence: C)
2. A bioprosthesis is reasonable for MV replacement in patients 65 years of age or older. (Level of Evidence: C)
3. A bioprosthesis is reasonable for MV replacement in patients under 65 years of age in sinus rhythm who elect to receive this valve for lifestyle considerations after detailed discussions of the risks of anticoagulation versus the likelihood that a second MV replacement may be necessary in the future. (Level of Evidence: C)

Tricuspid Valve Surgery

Class I

Severe TR in the setting of surgery for multivalvular disease should be corrected. (Level of Evidence: C)

Class IIa

Tricuspid annuloplasty is reasonable for mild TR in patients undergoing MV surgery when there is pulmonary hypertension or tricuspid annular dilatation. (Level of Evidence: C)

Intraoperative Assessment

Class I

1. Intraoperative transesophageal echocardiography is recommended for valve repair surgery. (Level of Evidence: B)
2. Intraoperative transesophageal echocardiography is recommended for valve replacement surgery with a stentless xenograft, homograft, or autograft valve. (Level of Evidence: B)
3. Intraoperative transesophageal echocardiography is recommended for valve surgery for infective endocarditis. (Level of Evidence: B)

Class IIa

Intraoperative transesophageal echocardiography is reasonable for all patients undergoing cardiac valve surgery. (Level of Evidence: C)

Management of Patients With Prosthetic Heart Valves

Antithrombotic Therapy

Class I

1. After AVR with bileaflet mechanical or Medtronic Hall prostheses, in patients with no risk factors,* warfarin is indicated to achieve an INR of 2.0 to 3.0. If the patient has risk factors, warfarin is indicated to achieve an INR of 2.5 to 3.5. (Level of Evidence: B)

2. After AVR with Starr-Edwards valves or mechanical disc valves (other than Medtronic Hall prostheses), in patients with no risk factors,* warfarin is indicated to achieve an INR of 2.5 to 3.5. (Level of Evidence: B)
3. After MV replacement with any mechanical valve, warfarin is indicated to achieve an INR of 2.5 to 3.5. (Level of Evidence: C)
4. After AVR or MV replacement with a bioprosthesis and no risk factors,* aspirin is indicated at 75 to 100 mg per day. (Level of Evidence: C)
5. After AVR with a bioprosthesis and risk factors,* warfarin is indicated to achieve an INR of 2.0 to 3.0. (Level of Evidence: C)
6. After MV replacement with a bioprosthesis and risk factors,* warfarin is indicated to achieve an INR of 2.5 to 3.5. (Level of Evidence: C)
7. For those patients who are unable to take warfarin after MV replacement or AVR, aspirin is indicated in a dose of 75 to 325 mg per day. (Level of Evidence: B)
8. The addition of aspirin 75 to 100 mg once daily to therapeutic warfarin is recommended for all patients with mechanical heart valves and those patients with biological valves who have risk factors.* (Level of Evidence: B)

Class IIa

1. During the first 3 months after AVR with a mechanical prosthesis, it is reasonable to give warfarin to achieve an INR of 2.5 to 3.5. (Level of Evidence: C)
2. During the first 3 months after AVR or MV replacement with a bioprosthesis, in patients with no risk factors,* it is reasonable to give warfarin to achieve an INR of 2.0 to 3.0. (Level of Evidence: C)

Class IIb

In high-risk patients with prosthetic heart valves in whom aspirin cannot be used, it may be reasonable to give clopidogrel (75 mg per day) or warfarin to achieve an INR of 3.5 to 4.5. (Level of Evidence: C)

*Risk factors include atrial fibrillation, previous thromboembolism, LV dysfunction, and hypercoagulable condition.

Recommendations for Antithrombotic Therapy in Patients With Prosthetic Heart Valves

	Aspirin (75–100 mg)	Warfarin (INR 2.0–3.0)	Warfarin (INR 2.5–3.5)	No Warfarin
Mechanical prosthetic valves				
AVR—low risk				
Less than 3 months	Class I	Class I	Class IIa	
Greater than 3 months	Class I	Class I		
AVR—high risk	Class I		Class I	
MVR	Class I		Class I	
Biological				

	Aspirin (75–100 mg)	Warfarin (INR 2.0–3.0)	Warfarin (INR 2.5–3.5)	No Warfarin
prosthetic valves				
AVR—low risk				
Less than 3 months	Class I	Class IIa		Class IIb
Greater than 3 months	Class I			Class IIa
AVR—high risk	Class I	Class I		
MVR—low risk				
Less than 3 months	Class I	Class IIa		
Greater than 3 months	Class I			Class IIa
MVR—high risk	Class I	Class I		

Depending on patients' clinical status, antithrombotic therapy must be individualized. In patients receiving warfarin, aspirin is recommended in virtually all situations. Risk factors: atrial fibrillation, left ventricular dysfunction, previous thromboembolism, and hypercoagulable condition. International normalized ratio (INR) should be maintained between 2.5 and 3.5 for aortic disc valves and Starr-Edwards valves. Modified from McAnulty JH, Rahimtoola SH. Antithrombotic therapy in valvular heart disease. In:Schlant R, Alexander RW, editors. Hurst's The Heart. New York, NY: McGraw-Hill, 1998:1867–74 (934).

Bridging Therapy in Patients With Mechanical Valves Who Require Interruption of Warfarin Therapy for Noncardiac Surgery, Invasive Procedures, or Dental Care

Class I

1. In patients at low risk of thrombosis, defined as those with a bileaflet mechanical AVR with no risk factors,* it is recommended that warfarin be stopped 48 to 72 hour before the procedure (so the INR falls to less than 1.5) and restarted within 24 h after the procedure. Heparin is usually unnecessary. (Level of Evidence: B)
2. In patients at high risk of thrombosis, defined as those with any mechanical MV replacement or a mechanical AVR with any risk factor, therapeutic doses of intravenous UFH should be started when the INR falls below 2.0 (typically 48 h before surgery), stopped 4 to 6 h before the procedure, restarted as early after surgery as bleeding stability allows, and continued until the INR is again therapeutic with warfarin therapy. (Level of Evidence: B)

Class IIa

It is reasonable to give fresh frozen plasma to patients with mechanical valves who require interruption of warfarin therapy for emergency noncardiac surgery, invasive procedures, or dental care. Fresh frozen plasma is preferable to high-dose vitamin K1. (Level of Evidence: B)

Class IIb

In patients at high risk of thrombosis (see above), therapeutic doses of subcutaneous UFH (15,000 units every 12 h) or LMWH (100 units per kg every 12 hours) may be considered during the period of a subtherapeutic INR. (Level of Evidence: B)

Class III

In patients with mechanical valves who require interruption of warfarin therapy for noncardiac surgery, invasive procedures, or dental care, high-dose vitamin K1 should not be given routinely, because this may create a hypercoagulable condition. (Level of Evidence: B)

*Risk factors: atrial fibrillation, previous thromboembolism, LV dysfunction, hypercoagulable conditions, older generation thrombogenic valves, mechanical tricuspid valves, or more than 1 mechanical valve.

Thrombosis of Prosthetic Heart Valves

Class I

1. Transthoracic and Doppler echocardiography is indicated in patients with suspected prosthetic valve thrombosis to assess hemodynamic severity. (Level of Evidence: B)
2. Transesophageal echocardiography and/or fluoroscopy is indicated in patients with suspected valve thrombosis to assess valve motion and clot burden. (Level of Evidence: B)

Class IIa

1. Emergency operation is reasonable for patients with a thrombosed left-sided prosthetic valve and NYHA functional class III–IV symptoms. (Level of Evidence: C)
2. Emergency operation is reasonable for patients with a thrombosed left-sided prosthetic valve and a large clot burden. (Level of Evidence: C)
3. Fibrinolytic therapy is reasonable for thrombosed right-sided prosthetic heart valves with NYHA class III–IV symptoms or a large clot burden. (Level of Evidence C)

Class IIb

1. Fibrinolytic therapy may be considered as a first-line therapy for patients with a thrombosed left-sided prosthetic valve, NYHA functional class I–II symptoms, and a small clot burden. (Level of Evidence: B)
2. Fibrinolytic therapy may be considered as a first-line therapy for patients with a thrombosed left-sided prosthetic valve, NYHA functional class III–IV symptoms, and a small clot burden if surgery is high risk or not available. (Level of Evidence: B)
3. Fibrinolytic therapy may be considered for patients with an obstructed, thrombosed left-sided prosthetic valve who have NYHA functional class II–IV

symptoms and a large clot burden if emergency surgery is high risk or not available. (Level of Evidence: C)
4. Intravenous UFH as an alternative to fibrinolytic therapy may be considered for patients with a thrombosed valve who are in NYHA functional class I–II and have a small clot burden. (Level of Evidence: C)

Follow-Up Visits

Class I

1. For patients with prosthetic heart valves, a history, physical examination, and appropriate tests should be performed at the first postoperative outpatient evaluation, 2 to 4 weeks after hospital discharge. This should include a transthoracic Doppler echocardiogram if a baseline echocardiogram was not obtained before hospital discharge. (Level of Evidence: C)
2. For patients with prosthetic heart valves, routine follow-up visits should be conducted annually, with earlier re-evaluations (with echocardiography) if there is a change in clinical status. (Level of Evidence: C)

Class IIb

Patients with bioprosthetic valves may be considered for annual echocardiograms after the first 5 years in the absence of a change in clinical status. (Level of Evidence: C)

Class III

Routine annual echocardiograms are not indicated in the absence of a change in clinical status in patients with mechanical heart valves or during the first 5 years after valve replacement with a bioprosthetic valve. (Level of Evidence: C)

Follow-Up Visits in Patients With Complications

Class I

Patients with LV systolic dysfunction after valve surgery should receive standard medical therapy for systolic heart failure. This therapy should be continued even if there is improvement of LV dysfunction. (Level of Evidence: B)

Evaluation and Treatment of Coronary Artery disease in Patients With Valvular Heart Disease

Diagnosis of Coronary Artery Disease

Class I

1. Coronary angiography is indicated before valve surgery (including infective endocarditis) or mitral balloon commissurotomy in patients with chest pain, other objective evidence of ischemia, decreased LV systolic function, history of CAD, or coronary risk factors (including age). Patients undergoing mitral

balloon valvotomy need not undergo coronary angiography solely on the basis of coronary risk factors. (Level of Evidence: C)
2. Coronary angiography is indicated in patients with apparently mild to moderate valvular heart disease but with progressive angina (Canadian Heart Association functional class II or greater), objective evidence of ischemia, decreased LV systolic function, or overt congestive heart failure. (Level of Evidence: C)
3. Coronary angiography should be performed before valve surgery in men aged 35 years or older, premenopausal women aged 35 years or older who have coronary risk factors, and postmenopausal women. (Level of Evidence: C)

Class IIa

Surgery without coronary angiography is reasonable for patients having emergency valve surgery for acute valve regurgitation, aortic root disease, or infective endocarditis. (Level of Evidence: C)

Class IIb

Coronary angiography may be considered for patients undergoing catheterization to confirm the severity of valve lesions before valve surgery without preexisting evidence of CAD, multiple coronary risk factors, or advanced age. (Level of Evidence: C)

Class III

1. Coronary angiography is not indicated in young patients undergoing nonemergency valve surgery when no further hemodynamic assessment by catheterization is deemed necessary and there are no coronary risk factors, no history of CAD, and no evidence of ischemia. (Level of Evidence: C)
2. Patients should not undergo coronary angiography before valve surgery if they are severely hemodynamically unstable. (Level of Evidence: C)

Treatment of Coronary Artery Disease at the Time of Aortic Valve Replacement

Class I

Patients undergoing AVR with significant stenoses (greater than or equal to 70% reduction in luminal diameter) in major coronary arteries should be treated with bypass grafting. (Level of Evidence: C)

Class IIa

1. In patients undergoing AVR and coronary bypass grafting, use of the left internal thoracic artery is reasonable for bypass of stenoses of the left anterior descending coronary artery greater than or equal to 50% to 70%. (Level of Evidence: C)
2. For patients undergoing AVR with moderate stenosis (50% to 70% reduction in luminal diameter), it is reasonable to perform coronary bypass grafting in major coronary arteries. (Level of Evidence: C)

Aortic Valve Replacement in Patients Undergoing Coronary Artery Bypass Surgery

Class I

AVR is indicated in patients undergoing CABG who have severe AS who meet the criteria for valve replacement (see Section 3.1.7 of the original guideline document). (Level of Evidence: C)

Class IIa

AVR is reasonable in patients undergoing CABG who have moderate AS (mean gradient 30 to 50 mm Hg or Doppler velocity 3 to 4 m per second). (Level of Evidence: B)

Class IIb

AVR may be considered in patients undergoing CABG who have mild AS (mean gradient less than 30 mm Hg or Doppler velocity less than 3 m per second) when there is evidence, such as moderate-severe valve calcification, that progression may be rapid. (Level of Evidence: C)

Definitions:

Classification of Recommendations

Class I: Conditions for which there is evidence and/or general agreement that a given procedure or treatment is beneficial, useful, and effective.

Class II: Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment.

Class IIa: Weight of evidence/opinion is in favor of usefulness/efficacy.

Class IIb: Usefulness/efficacy is less well established by evidence/opinion.

Class III: Conditions for which there is evidence and/or general agreement that a procedure/treatment is not useful/effective and in some cases may be harmful.

Levels of Evidence

A: Data derived from multiple randomized clinical trials.

B: Data derived from a single randomized trial, or nonrandomized studies.

C: Only consensus opinion of experts, case studies, or standard-of-care

CLINICAL ALGORITHM(S)

Algorithms are provided in the original guideline document for

- Strategy for Evaluating Heart Murmurs
- Management Strategy for Patients with Severe Aortic Stenosis
- Management Strategy for Patients with Chronic Severe Aortic Regurgitation
- Management Strategy for Patients with Mitral Stenosis
- Management Strategy for Patients with Mitral Stenosis and Mild Symptoms
- Management Strategy for Patients with Mitral Stenosis and Moderate to Severe Symptoms
- Management Strategy for Patients with Chronic Severe Mitral Regurgitation

EVIDENCE SUPPORTING THE RECOMMENDATIONS

REFERENCES SUPPORTING THE RECOMMENDATIONS

References open in a new window

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The type of evidence supporting each recommendation is specifically stated (see "Major Recommendations").

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

- Appropriate and effective utilization of diagnostic procedures in the management of patients with valvular heart disease.
- Effective treatment of patients with valvular heart disease, resulting in improved hemodynamic and functional status and survival.

POTENTIAL HARMS

Not stated

CONTRAINDICATIONS

CONTRAINDICATIONS

- Intra-aortic balloon counterpulsation is contraindicated for acute aortic regurgitation.
- Contraindications to the use of aspirin include bleeding or aspirin intolerance.
- Relative contraindications to percutaneous balloon valvotomy for mitral stenosis include the presence of a left atrial thrombus and significant (3+ to 4+) mitral regurgitation (MR).
- Surgery for endocarditis is not indicated if complications (severe embolic cerebral damage) or comorbid conditions make the prospect of recovery remote.

- The manufacturer considers the use of warfarin during pregnancy to be strictly contraindicated because of its association with embryopathy, consisting of nasal hypoplasia and/or stippled epiphyses after in utero exposure during the first trimester of pregnancy, and central nervous system abnormalities after exposure during any trimester.

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

- Many factors ultimately determine the most appropriate treatment of individual patients with valvular heart disease within a given community. These include the availability of diagnostic equipment and expert diagnosticians, the expertise of interventional cardiologists and surgeons, and notably, the wishes of well-informed patients. Therefore, deviation from these guidelines may be appropriate in some circumstances. These guidelines are written with the assumption that a diagnostic test can be performed and interpreted with skill levels consistent with previously reported American College of Cardiology (ACC) training and competency statements and ACC/American Heart Association (AHA) guidelines, that interventional cardiological and surgical procedures can be performed by highly trained practitioners within acceptable safety standards, and that the resources necessary to perform these diagnostic procedures and provide this care are readily available. This is not true in all geographic areas, which further underscores the committee's position that its recommendations are guidelines and not rigid requirements.
- This task force report overlaps with several previously published ACC/AHA guidelines about cardiac imaging and diagnostic testing, including the guidelines for the clinical use of cardiac radionuclide imaging (1), the clinical application of echocardiography (2), exercise testing (3), and percutaneous coronary intervention (4). Although these guidelines are not intended to include detailed information covered in previous guidelines on the use of imaging and diagnostic testing, an essential component of this report is the discussion of indications for these tests in the evaluation and treatment of patients with valvular heart disease.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Pocket Guide/Reference Cards

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Living with Illness

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

American College of Cardiology (ACC), American Heart Association (AHA), Task Force on Practice Guidelines, (Committee on Management of Patients with Valvular Heart Disease). ACC/AHA guidelines for the management of patients with valvular heart disease. J Am Coll Cardiol 1998 Nov;32(5):1486-588. [737 references] PubMed

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1998 Nov 1 (revised 2006)

GUIDELINE DEVELOPER(S)

American College of Cardiology Foundation - Medical Specialty Society
American Heart Association - Professional Association

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American College of Cardiology/American Heart Association Task Force on Practice Guidelines

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FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

The American College of Cardiology/American Heart Association (ACC/AHA) Task Force on Practice Guidelines makes every effort to avoid any actual, potential, or perceived conflicts of interest that might arise as a result of an outside relationship or personal interest of a member of the writing committee. Specifically, all members of the writing committee, as well as peer reviewers of the document, are asked to provide disclosure statements of all such relationships that might be perceived as real or potential conflicts of interest. These statements are reviewed by the parent task force, reported orally to all members of the writing panel at each meeting, and updated and reviewed by the writing committee as changes occur.

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Dr. Peter Lockhart	Content Reviewer–AHA Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee	None	None	None	None
Dr. Joseph Mathew	Organizational Reviewer–Society of	None	None	None	None

Peer Reviewer	Representation	Research Grant	Speakers' Bureau/Honoraria	Stock Ownership	Consultant/Advisory Member
	Cardiovascular Anesthesiologists				
Dr. Debabrata Mukherjee	Content Reviewer–ACCF Cardiac Catheterization and Intervention Committee	None	None	None	None
Dr. Robert Robbins	Official Reviewer (surgery)–AHA	None	None	None	None
Dr. Carlos Ruiz	Content Reviewer–ACCF Cardiac Catheterization and Intervention Committee	None	None	None	None
Dr. Richard Shemin	Content Reviewer–ACCF Cardiovascular Surgery Committee; Organizational Reviewer–Society of Thoracic Surgeons	None	None	None	Edwards Life Sciences; 3f Therapeutics; St. Jude Medical
Dr. Stanton Shernan	Organizational Reviewer–Society of Cardiovascular Anesthesiologists	None	None	None	None
Dr. Thoralf Sundt	Content Reviewer–ACCF Cardiac Catheterization and Intervention Committee	CarboMedics	None	None	None
Dr. Kathryn Taubert	Content Reviewer–AHA Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee	None	None	None	None
Dr. Zoltan Turi	Organizational Reviewer–Society for Cardiovascular	None	None	None	None

Peer Reviewer	Representation	Research Grant	Speakers' Bureau/Honoraria	Stock Ownership	Consultant/Advisory Member
	Angiography and Interventions				
Dr. Roberta Williams	Content Reviewer–ACC/AHA Management of Adults With Congenital Heart Disease	None	None	None	None
Dr. William Zoghbi	Content Reviewer–Individual Review	None	None	None	None

ACC = American College of Cardiology; ACCF = American College of Cardiology Foundation; AHA = American Heart Association

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GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: American College of Cardiology (ACC), American Heart Association (AHA), Task Force on Practice Guidelines, (Committee on Management of Patients with Valvular Heart Disease). ACC/AHA guidelines for the management of patients with valvular heart disease. J Am Coll Cardiol 1998 Nov;32(5):1486-588.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American College of Cardiology (ACC) Web site, and from the American Heart Association (AHA) Web site.

Print copies: Available from the American College of Cardiology, Resource Center, 9111 Old Georgetown Rd, Bethesda, MD 20814-1699.

AVAILABILITY OF COMPANION DOCUMENTS

The following is available:

- ACC/AHA pocket guideline. Management of patients with valvular heart disease. 2006 Jun. 58 p.

Electronic copies: Available in Portable Document Format (PDF) from the American College of Cardiology (ACC) Web site.

Print copies: Available from the American College of Cardiology, Resource Center, 9111 Old Georgetown Rd, Bethesda, MD 20814-1699.

PATIENT RESOURCES

Not stated

NGC STATUS

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